

element. In this case, the pitch element of the counterpart voice is changed due to the sub-harmonic signal and thus, the parameter analyzer 123 may determine the counterpart voice as an abnormal voice if the pitch is more than twice as high as a normal voice.

[0046] Alternatively, if the voice parameter is a harmonic-to-noise ratio, the parameter analyzer 123 may determine whether the harmonic-to-noise ratio is higher than a predetermined value. For example, as illustrated in FIG. 3B, when the harmonic-to-noise ratio is higher than a predetermined value, the parameter analyzer 123 may determine that the counterpart voice is a normal signal, but alternatively as illustrated in FIG. 3C, when the harmonic-to-noise ratio is less than a predetermined value, the parameter analyzer 123 may determine that the counterpart voice is an abnormal voice. Further, as illustrated in FIGS. 3D through 3F, the harmonic-to-noise ratio may contain a bigger difference between a normal voice and an abnormal voice in a high frequency band, and thus the parameter analyzer 123 may determine a harmonic-to-noise ratio by analyzing a frequency band which is higher than a predetermined frequency band when determining whether a normal voice or an abnormal voice is detected.

[0047] If the voice parameter is an open quotient, the parameter analyzer 123 may calculate an energy ratio of the first harmonic signal element and the second harmonic signal element, and determine whether the counterpart voice is normal or abnormal. Specifically, if an open quotient is within a predetermined scope (for example, 0.4-0.6), the parameter analyzer 123 may determine that the counterpart voice is normal. For example, when the open quotient is calculated as 0.5 as illustrated in the graph of FIG. 3E, the parameter analyzer 123 may determine that the counterpart voice is normal. However, when the open quotient is out of a predetermined range, the parameter analyzer 123 may determine that the counterpart voice is abnormal. That is, if the open quotient is too large or too small, it is highly likely that the counterpart voice is a deafening or a dry voice, the parameter analyzer 123 may therefore determine that the counterpart voice is abnormal. For example, if the open quotient (0.7) is higher than a predetermined scope or the open quotient (0.3) is less than a predetermined scope as illustrated in the graph of FIG. 3D, the parameter analyzer 123 may determine that the counterpart voice is abnormal.

[0048] Further, if the voice parameter is a GRBAS score, and at least one of G (grade, general impression), R (roughness, rough sound and irregular vibration of vocal cords), B (breathiness), A (asthenia), and S (strain) is higher than a predetermined value, the parameter analyzer 123 may determine that the counterpart voice is abnormal.

[0049] Meanwhile, the above-described voice parameters are only examples, and whether a counterpart voice is abnormal may be determined based on other voice parameters.

[0050] When it is determined that a counterpart voice is abnormal, the abnormal voice determiner 120 may output the counterpart voice to the normal voice converter 130, and when it is determined that a counterpart voice is normal, the abnormal voice determiner 120 may output the counterpart voice to the voice output unit 140.

[0051] If a voice signal of a counterpart whose voice is determined to be abnormal and is received, the normal voice converter 130 converts the counterpart voice to a normal voice. Specifically, the normal voice converter 130 may

convert an abnormal voice to a normal voice by adjusting a harmonic element of the counterpart voice.

[0052] For example, the counterpart voice, which is determined to be abnormal, may include a weak harmonic signal as illustrated in area 410 of FIG. 4A, or may include a sub-harmonic signal which is determined to be a noise element between harmonic signals as illustrated in area 420 of FIG. 4A. Accordingly, the normal voice converter 130 may emphasize the weak harmonic signal element as illustrated in area 430 of FIG. 4A, or may remove the sub-harmonic signal between harmonic signals as illustrated in area 440 of FIG. 4A.

[0053] Further, the counterpart voice may be determined to be abnormal because it may not include a harmonic signal as illustrated in area 450 of FIG. 4B. Accordingly, the normal voice converter 130 may generate a harmonic signal using a harmonic generation filter as illustrated in area 460 of FIG. 4B.

[0054] That is, as described above, the normal voice converter 130 may convert an abnormal voice into a normal voice by generating or emphasizing a harmonic element, or by removing a sub-harmonic element.

[0055] According to another exemplary embodiment, generating or emphasizing a harmonic element or removing a sub-harmonic element may be achieved as follows. Particularly, a determination of a primary voice harmonic with a frequency and phase may be established. Then it may be possible to generate an oscillating gain signal with the frequency and phase of the primary voice harmonic, and the generated oscillating gain signal may be added to the primary voice harmonic.

[0056] Further, according to another exemplary embodiment, the normal voice converter 130 may adjust a conversion intensity according to a user input, which may also be referred to as an input user command, that is received through a user interface for adjusting the conversion intensity for converting an abnormal voice into a normal voice. For example, as illustrated in FIG. 5, if a voice conversion intensity is adjusted through the UI 500 for adjusting the voice conversion intensity, the normal voice converter 130 may convert an abnormal voice into a normal voice according to the adjusted voice conversion intensity selected by the user. Particularly, the stronger the selected voice conversion intensity is, the more the normal voice converter 130 may emphasize a harmonic signal, and the more completely the normal voice converter 130 may remove a sub-harmonic signal. On the other hand, the weaker the selected voice conversion intensity is, the less the normal voice converter 130 may emphasize a harmonic signal, and the normal voice converter 130 may not remove a sub-harmonic signal completely and instead, may reduce the sub-harmonic signal to a predetermined ratio.

[0057] In addition, the normal voice converter 130 may convert only part of the characteristics of an abnormal voice to a normal voice. For example, the normal voice converter 130 may remove only a sub-harmonic element while maintaining a harmonic element, or may emphasize only a harmonic element while maintaining a sub-harmonic element.

[0058] That is, by setting a conversion intensity and method according to a user input, the user may convert a counterpart voice to a normal voice so that the voice is suitable for the user.